

IPSYS – A simulation tool for performance assessment and controller development of integrated power systems with distributed renewable energy generation and storage

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Contents

- Introduction
- IPSYS main features
- Simulation example
- Results
- Future developments
- Conclusion

Introduction

- Systems (isolated, villages or islands) with renewable energy sources are potentially attractive in many places
- It is necessary in the design and evaluation phases to be able to compare options
- Often electricity is not the only service provided by such systems. Other services include fresh water, heat, cold etc.
- Systems will often be complex: several sources, storage, control
- Control is a key factor - detailed modelling of the impact of different control strategies very important
- IPSYS is to supplement other models for e.g. screening, dynamic analysis etc.

IPSYS – Main design objectives

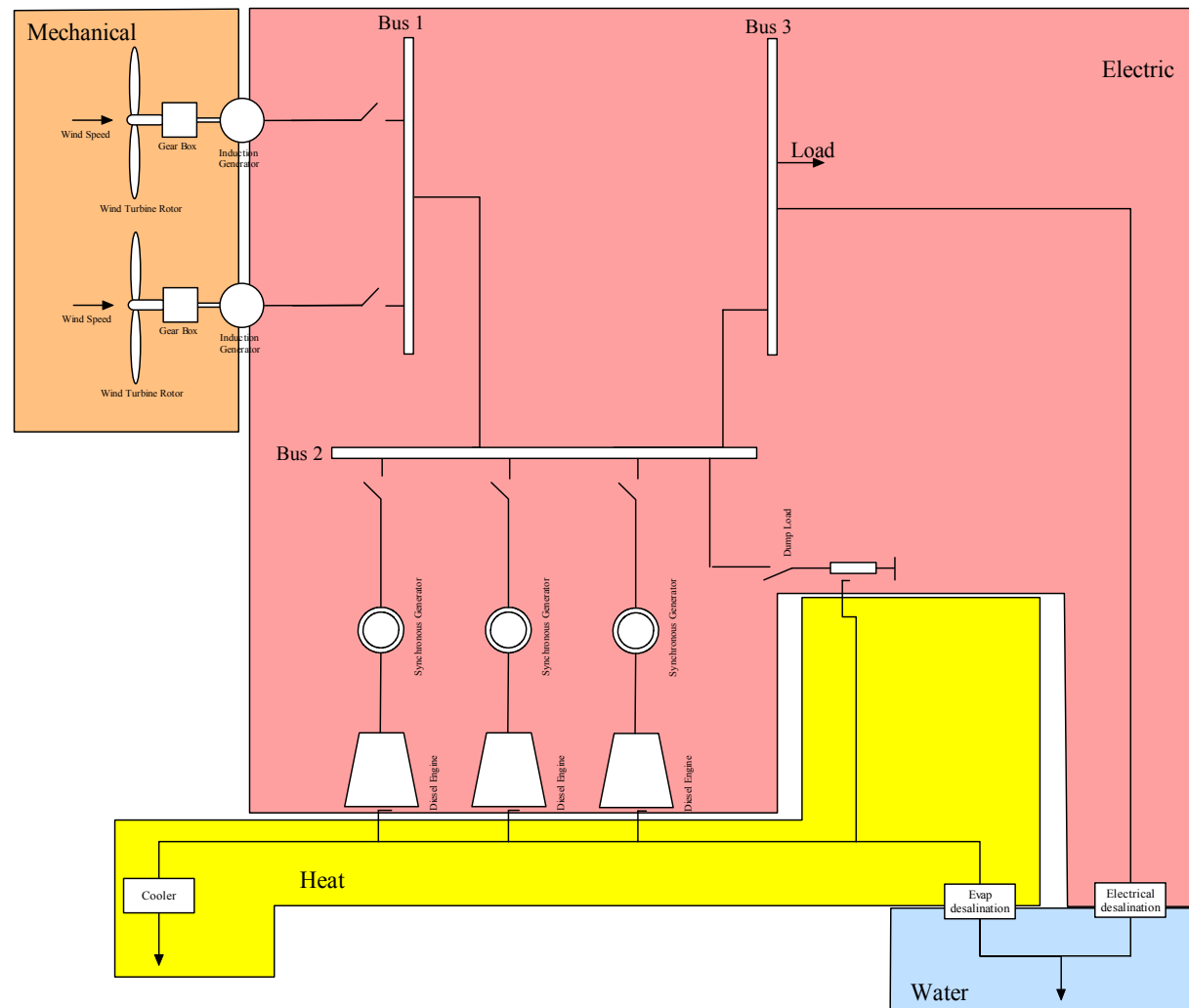
- Technical performance simulation of isolated systems – small systems as well as larger
- Modelling of controllers should be close to reality
- Inclusion of new types of generators, consumers and other components in the system should be relatively easy
- Allow for different types of input (time series, statistical) for various components (energy resources, consumption ...)

IPSYS – main features

- Explicit modelling of the electrical network, i.e. load flow.
- Explicit modelling of load sharing between generating units, for active and reactive power.
- Flexible modelling of system configuration.
- Flexible modelling of supervisory controllers.
- Short time steps for accurate modelling of a supervisory controller.
- Ability to explicitly include other circuits/balances that interact with the electrical system (and system control) in order to model other products/services.
- Integration with the WAsP wind resource estimation tool.

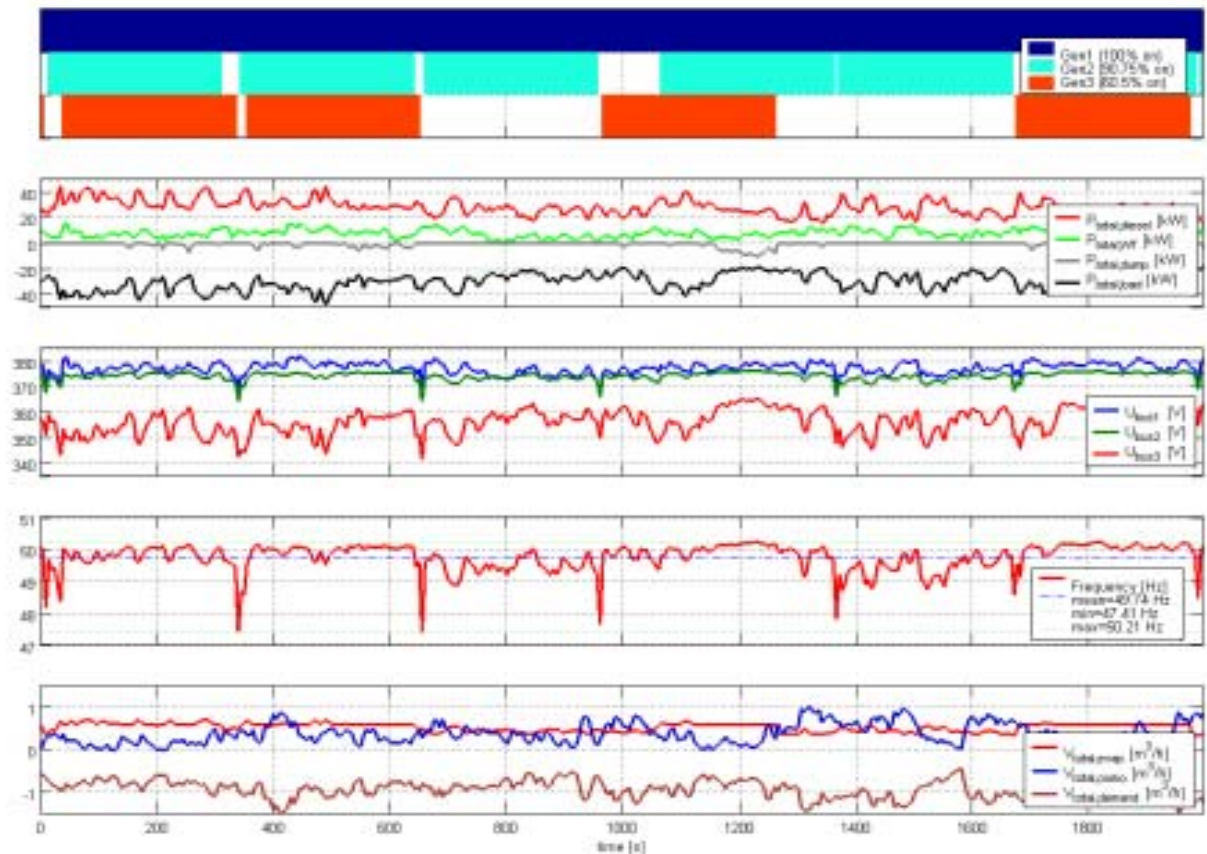
Simulation example

- Different domains are explicitly modelled including feedback between them
- Input modelled for each wind turbine load etc.
- Controllers can be exchanged



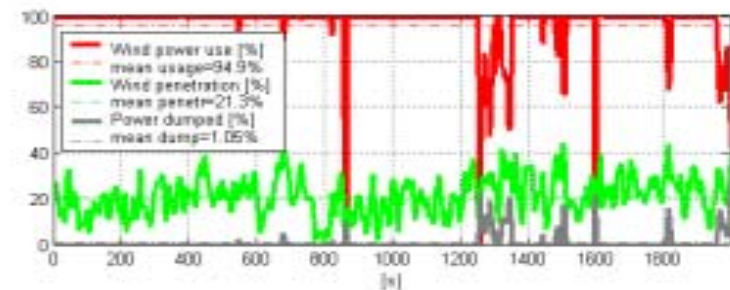
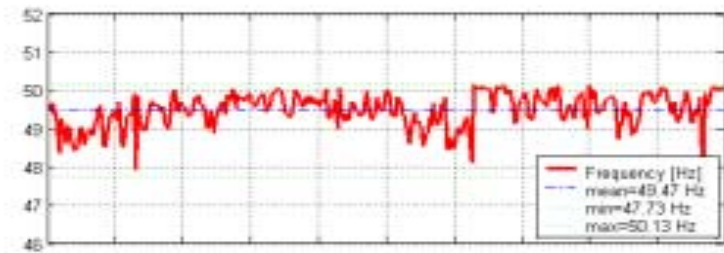
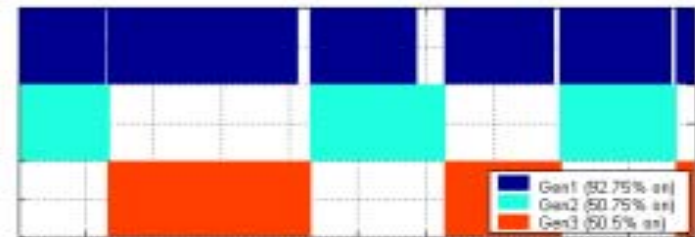
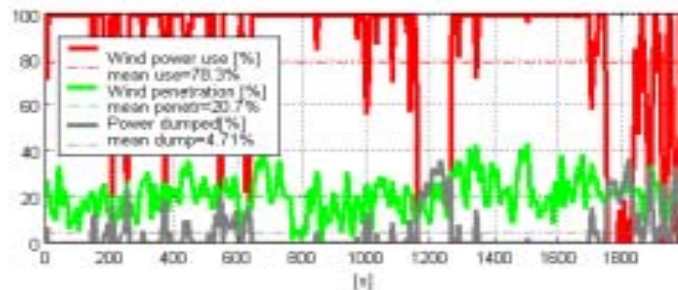
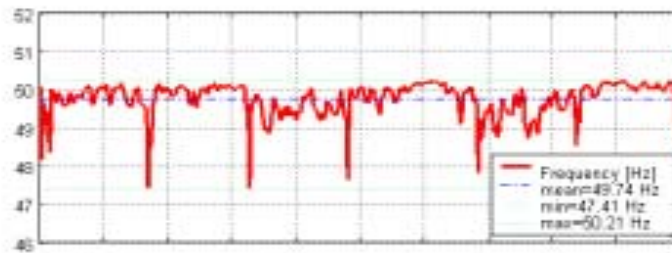
Results I

- Diesel load sharing explicitly modelled (here: droop mode)
- Voltage at the three bus bar are calculated
- Water from the two desal units meets demand



Results II- Two control strategies

- Based on diesel genset load
- minimum run time
- Based on load and wind margins
- minimum run time



- The software package is currently being compared with existing models
- The system used for verification is a +120 bus bar system with more than 70 loads, 10 diesel gensets and six wind turbines
- Preliminary results show good agreement with other models

Future developments

- Currently being used for investigations of battery performance in wind diesel systems
- User interface will be constructed
- The flexible controller modelling will be extended
- Other components will be included as need arises

Conclusion

- The IPSYS software package is especially developed for simulation of integrated power systems
- Its main features are
 - Detailed modelling of the the electrical network including active and reactive power constrains,
 - Flexible system configuration and controller modelling
 - Modelling of several domains (electric, heat, water)
- It is now ready for being used in real projects